Bridging the gap between theoretical syntax and large language models: Can Hopf algebras do the job?

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Modern algebraic models of syntax, informed by considerations of machine learning, have been proposed before (Coecke, Sadrzadeh and Clark 2010 used pregroup grammars, Kornai 2010 used Eilenberg machines, and Kartsaklis 2014 used Frobenius algebras), but renewed interest in the subject is largely due to recent work on Minimalism by Marcolli, Chomsky, and Berwick (2023, 2023a), who rely on Hopf algebras, the same broad class of structures that seems relevant to an understanding of Large Language Models (Nemecek 2023). This sets the stage for a research program whereby understanding natural language (both narrow and broad faculty) is leveraged to an understanding of LLMs, with syntax at the center of the language faculty, minimalism at the center of syntax, and HAs at the center of minimalism.

In the first half of this talk we attempt to bring the interested syntactician up to speed on HAs, assuming only undergrad level abstract algebra and linear algebra as prerequisites, and illustrating the concepts that play a key role in HAs, tensor products and antipodes, by simple examples. In the second half we bring this machinery to bear on two issues, workspaces and agreement. Remarkably, it is workspaces that are in the focus of Marcolli et al's work, and agreement, a subject of great interest to syntacticians, gets a short shrift. We propose to treat bound morphemes (both phi-features, and roots in the sense of Harley 2014) on a par with free morphemes (stems, fully independent lexical items) with the combinatorics largely managed by (hyper)graph unification.